the Sun has an atmosphere. The effect would be produced whether the atmospheric refraction be of the first of the two kinds before mentioned, or the second, but would be less conspicuous in the latter case than in the other. With respect to *Jupiter*, also, I have frequently remarked, that the features of the disk appeared more distinct near the centre than towards the periphery; and on the occasion of the occultation of this planet on January 2, 1857, I made the note that when it emerged from the Moon's bright limb, it appeared "brighter at the central parts than towards the border, and had in consequence something of a pellucid appearance." (See *Monthly Notices*, vol. xvii. p. 138). These phenomena are readily explained by the supposition of an atmosphere.

Cambridge, April 13, 1863.

On an Eclipse of the Sun recorded in the Chinese Annals as having occurred at a very early Period of their History. By Mr. Williams, Assistant-Secretary.

A few weeks since Mr. Hind requested me to look into the annals of China, with a view of ascertaining the particulars of a very early Solar Eclipse, said to be recorded in their most ancient historical work, the *Shoo King*, a copy of which is in my possession. I accordingly undertook the task, and the information thus obtained appearing to be of considerable interest, I am induced to lay it before the Society, it being the earliest record known of a Solar Eclipse. I therefore will very briefly give the result of this investigation, explaining, at the same time, the process by which it has been obtained. It is to be remembered that it is the Chinese account only I now lay before you, leaving its corroboration or disproval to those more competent than myself to enter into that part of the subject.

In the 書經 *Shoo King*—the most ancient historical work of the Chinese—in the second section of that work, under the 夏 Hea Dynasty, it is related that, in the reign of 仲康, Chung Kang, the fourth Emperor of that Dynasty, an Eclipse of the Sun took place. The passage recording this Eclipse occurs incidentally in an account of the delinquency of 羲 He and 和 Ho, two important officers, who appear to have had the superintendence of the Imperial Astronomical Board, as it may be called, and who, giving themselves up to wine, neglected their duties, and consequently, failing in the prediction of the Eclipse in question, rendered themselves

liable to punishment for that offence. The prediction of an eclipse was a matter of very great importance in China, as certain religious ceremonies were required to be performed, both by the Emperor and the people on these occasions, of which it was necessary that due notice should be given, in order that the requisite preparations should be made.

The passage recording the Eclipse is as follows, beginning to the right and reading downwards:—

集 Tseih	朔 So	季 Ke
于 Yu	辰 Shin	秋 Tsew
房 Fang	弗 Foo	月 Yue

which may be rendered, "In the last month of the autumn, the first day of the moon, the heavenly bodies were not in agreement in Fang."

I have not hitherto been able to find, in the *Shoo King*, any more definite date assigned to this Eclipse; but in other historical works in my possession the following passage occurs in each, which supplies this deficiency:—

元 Yuen	夏 Hea	壬 Jin
歲 Suy.	仲 Chung	戌 Seuh
	康 Kang	

This passage requires some explanation to render the observations that follow intelligible. The first two characters (Jin Seuh) are the cyclical characters of the year in question; the next (Hea) is the name of the dynasty; the next two (Chung Kang) are the name of the Emperor; and the last two (Yuen Suy) express "the first year." This sentence, then, is to be rendered, "In the year Jin Seuh of the Cycle, the first year of Chung Kang of the Hea Dynasty." The account that immediately follows this passage does not directly relate to the subject of the Eclipse, and is followed by the before-mentioned words of the *Shoo King*, commencing with "Tsew," and with the character for nine before the word "Yue" (month), consequently reading, "In the autumn, the ninth month, the first day of the moon," &c.

The notes in each of these works explain this passage as relating to an Eclipse of the Sun. In two of them we have a

further explanation of some of the expressions employed. Thus "Shin," the fifth character, is said to signify the "Sun and Moon;" and it is intimated that these luminaries are described as not being in "harmonious agreement in the division Fang."

It must, however, be mentioned, that in the great collection of Chinese historians, in three hundred volumes, entitled *She ke*, "*Historical Annals*," the early part of which was compiled in the century before the Christian era, although the neglect of He and Ho and their subsequent punishment are mentioned, no account of the occurrence of an Eclipse is given.

We have then, in the passage just quoted, a positive date assigned to this Eclipse, viz. "Jin Seuh," a certain year of a cycle, and the ninth month of that year. It remains, then, to show how this date is to be expressed in our notation. The mode of effecting this is, when explained, exceedingly simple, and the following is the course to be pursued:—The Chinese regulate their chronology by periods or cycles of 60 years. The years of these cycles are indicated, not by numerals, but by certain characters called by them Kea Tsze. These they divide into two series, the one of ten, the other of twelve characters, and the name Kea Tsze is derived from the names of the first characters in these series. They are employed in the following manner:—Combining the first characters in each series, we obtain the appellation of the first year of the Cycle, Kea Tsze. The second characters are combined for the second year, and so on to the eleventh, when the first character of the shorter series combines with the eleventh of the longer; and at the thirteenth the third of the shorter series combines with the first of the longer for the appellation of that year. Thus it goes on until, in the sixtieth year, the two last characters combine to form 60, and are followed in the sixty-first year by Kea Tsze, as before, when a new cycle commences.

We are now prepared to investigate the date of this Eclipse, as given in the Chinese annals. Upon examination, the characters at the commencement of the passage quoted (Jin Seuh) are found to be those answering to the fifty-ninth year of the cycle; and this particular cycle is considered by the Chinese to be the eighth of their series. Now it is reckoned that the seventy-fifth cycle commenced in the year 1804 of our era: consequently, seventy-four cycles were completed in 1803. Hence $74 \times 60 = 4440$ will give the number of years elapsed since the commencement of this mode of reckoning to 1803. Subtracting from that number the years of the Christian era, 1803, we obtain 2637 B.C. for the first year of the first cycle. Now we gather from the text, that the first year of Chung Kang was the fifty-ninth year of the eighth cycle, and, consequently, that seven cycles and fifty-nine years would be completed in that year. Consequently, that year was $7 \times 60 + 59 = 479$ years from the commencement of the cyclical mode of reckoning. Subtracting this from 2637,

we obtain 2158 B.C. as the date of the accession of Chung Kang; and as the eclipse occurred in the autumn of the same year, it must also be the date of that phenomenon.

We have now to consider the part of the heavens mentioned as the place where the eclipse took place; and here I may be allowed a few words in explanation of the mode in which the Chinese astronomers arrange the stars.

The visible heavens are divided by them into thirty-one parts. Three of these, called "yuen," are of considerable size. The first, called "Tsze wei yuen," comprises the Circumpolar stars, and may be considered as including those that never set in China. The second, named "Tai wei yuen," is bounded to the south by stars in *Virgo* and *Leo*, and includes to the north *Coma Berenices*, *Canes Venatici*, and some stars in *Ursa Major*. The third, "Teen she yuen," is bounded by stars in *Serpens* and *Hercules:* thus including the greater portion of *Ophiuchus*, the constellation *Hercules*, and other stars to the north.

The remaining twenty-eight divisions, called "Suh," of which *Fang* is one, may be considered as representing the lunar houses. They, however, are very irregular in extent, both from east to west and from north to south. Thus, while the smallest is less than one degree from east to west, the largest extends thirty-one degrees, and of the rest no two are alike in dimensions. In like manner, while one extends north and south from *Perseus* to *Canopus*, another consists merely of a few small stars in the head of *Orion*. Each of these twenty-eight divisions is determined by a certain group of stars having the name of the division, but frequently forming a very small portion of it, the name being common to the whole division, which may include various other asterisms wholly unconnected with the group thus named.

Thus, in the most extensive division Tsing, the group of stars so called consists of γ, ε, λ, μ, and other stars in *Gemini*, but the whole division extends 31° from east to west, and from *Perseus* in the north to *Canopus* in the south. It is necessary, in speculating on any phenomenon recorded in the Chinese books, to keep these circumstances in view, as an appearance described in these records as having occurred in Tsing, may be referred to any part of that division, and thus, without more definite information, its probable place cannot be identified with any degree of certainty.

The division Fang, in which this Eclipse is said to have occurred, is a very small one, being only about five degrees from east to west, and of but little extent from north to south. Its determining group consists of the stars β, δ, π, and ρ in *Scorpio*. It includes also a few small stars in *Libra* and *Ophiuchus* to the north, and in *Lupus* to the south. This, then, is the part of the heavens in which the Eclipse occurred; and, as it is a Solar Eclipse that is recorded, I presume there would be but little

difficulty in ascertaining the exact place of the Sun at the time mentioned.

The result then of this investigation, as far as I have carried it, is, that a Solar Eclipse is recorded in the most ancient Chinese historical work extant, as having occurred in the reign of Chung Kang, of the Hea dynasty, which Eclipse is more circumstantially mentioned by subsequent historians as having taken place in the first year of that Emperor, being the fifty-ninth year of the eighth cycle. That according to their mode of reckoning, the date of this Eclipse, expressed in our numbers, is 2158 B.C. and that it occurred in the ninth month of that year, in their division Fang, that asterism being part of our constellation *Scorpio*.

I have thus given the account of this Eclipse, simply as it occurs in Chinese historical works of reputation. There are, however, discrepancies in the year of the founding of the Hea dynasty, both in Chinese and European authorities, which may require attention. Leaving out one Chinese author, whose difference is upwards of 200 years, I find the first year of Yu, the founder of that dynasty, was according to one authority 2206, and according to the historians I have followed in this investigation 2204 B.C. According to what may be called European authorities, we have in Du Halde 2208, and in Gaubil 2205, as the date of that event. We have here then a difference of about four years, within which limits, I presume, should a Solar Eclipse be found to have occurred, satisfying the conditions as to time and place, it may reasonably be considered as that recorded in the curious and ancient book from which the preceding account has been taken.

I have also thought it necessary to give important passages in the original characters, knowing from experience the extreme difficulty of ascertaining with any degree of certainty the actual words intended to be employed, when their equivalent sounds are expressed in European letters only.* Whether a Solar Eclipse, visible in China, actually occurred at or near the time mentioned must be left for others to determine; and I can only say in conclusion, that should such be found to have been the case, it will afford a strong evidence of the general veracity of the early annals of that very ancient and interesting people.

On the Value of the Solar Parallax deduced from the Lunar Tables. By P. A. Hansen.

In the *Monthly Notices*, vol. xxiii. No. 7, Mr. E. J. Stone discusses different values of the co-efficient of the Parallactic

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